

PATENT COOPERATION TREATY

PCT

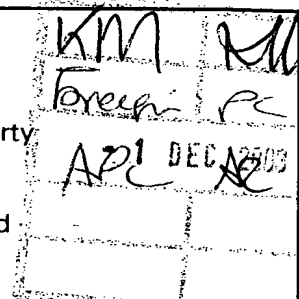
NOTIFICATION OF RECEIPT OF
RECORD COPY

(PCT Rule 24.2(a))

From the INTERNATIONAL BUREAU

To:

CARDUS, Alan, Peter
Marconi Intellectual Property
Marrable House
The Vineyards
Great Baddow, Chelmsford
Essex CM2 7QS
United Kingdom



| | |
|---|---|
| Date of mailing (day/month/year) 24 November 2003 (24.11.03) | IMPORTANT NOTIFICATION |
| Applicant's or agent's file reference P/63773/GPTX18 | International application No. PCT/IB03/05115 |

The applicant is hereby **notified** that the International Bureau has received the record copy of the international application as detailed below.

Name(s) of the applicant(s) and State(s) for which they are applicants:

MARCONI COMMUNICATIONS SPA (for all designated States except US)
FELLA, Paolo et al (for US)

International filing date : 13 October 2003 (13.10.03)
Priority date(s) claimed : 31 October 2002 (31.10.02)
Date of receipt of the record copy
by the International Bureau : 19 November 2003 (19.11.03)
List of designated Offices :

AP : GH,GM,KE,LS,MW,MZ,SD,SL,SZ,TZ,UG,ZM,ZW
EA : AM,AZ,BY,KG,KZ,MD,RU,TJ,TM
EP : AT,BE,BG,CH,CY,CZ,DE,DK,EE,ES,FI,FR,GB,GR,HU,IE,IT,LU,MC,NL,PT,RO,SE,SI,SK,TR
OA : BF,BJ,CF,CG,CI,CM,GA,GN,GQ,GW,ML,MR,NE,SN,TD,TG
National : AE,AG,AL,AM,AT,AU,AZ,BA,BB,BG,BR,BY,BZ,CA,CH,CN,CO,CR,CU,CZ,DE,DK,DM,DZ,
EC,EE,ES,FI,GB,GD,GE,GH,GM,HR,HU,ID,IL,IN,IS,JP,KE,KG,KP,KR,KZ,LC,LK,LR,LS,LT,LU,
LV,MA,MD,MG,MK,MN,MW,MX,MZ,NI,NO,NZ,OM,PG,PH,PL,PT,RO,RU,SC,SD,SE,SG,SK,SL,SY,TJ,
TM,TN,TR,TT,TZ,UA,UG,US,UZ,VC,VN,YU,ZA,ZM,ZW

ATTENTION

The applicant should carefully check the data appearing in this Notification. In case of any discrepancy between these data and the indications in the international application, the applicant should immediately inform the International Bureau.

In addition, the applicant's attention is drawn to the information contained in the Annex, relating to:

- ☒ time limits for entry into the national phase - **see updated important information (as of April 2002)**
☒ confirmation of precautionary designations (if applicable)
☒ requirements regarding priority documents (if applicable)

A copy of this Notification is being sent to the receiving Office and to the International Searching Authority.

| | |
|---|--|
| The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland | Authorized officer: Aysha FLEYFEL |
| Facsimile No. (41-22) 338-7060 | Telephone No. (41-22) 338 8301 |

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| CHELMSFORD | |
| PC | |
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| PCT | |

PCT/IB2003/005115

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

To:

CARDUS, Alan, Peter
Marconi Intellectual Property
Marrable House
The Vineyards
Great Baddow, Chelmsford
Essex CM2 7QS
United Kingdom

**NOTIFICATION CONCERNING
SUBMISSION OR TRANSMITTAL
OF PRIORITY DOCUMENT**

(PCT Administrative Instructions, Section 411)

| | |
|--|--|
| Date of mailing (day/month/year) 20 January 2004 (20.01.2004) | |
| Applicant's or agent's file reference P/63773/GPTX18 | IMPORTANT NOTIFICATION |
| International application No. PCT/IB2003/005115 | International filing date (day/month/year) 13 October 2003 (13.10.2003) |
| International publication date (day/month/year) Not yet published | Priority date (day/month/year) 31 October 2002 (31.10.2002) |
| Applicant MARCONI COMMUNICATIONS SPA et al | |

- By means of this Form, which replaces any previously issued notification concerning submission or transmittal of priority documents, the applicant is hereby notified of the date of receipt by the International Bureau of the priority document(s) relating to all earlier application(s) whose priority is claimed. Unless otherwise indicated by the letters "NR", in the right-hand column or by an asterisk appearing next to a date of receipt, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).
- (If applicable) The letters "NR" appearing in the right-hand column denote a **priority document which, on the date of mailing of this Form, had not yet been received by the International Bureau** under Rule 17.1(a) or (b). Where, under Rule 17.1(a), the priority document must be submitted by the applicant to the receiving Office or the International Bureau, but the applicant fails to submit the priority document within the applicable time limit under that Rule, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.
- (If applicable) An asterisk(*) appearing next to a date of receipt, in the right-hand column, denotes a **priority document submitted or transmitted to the International Bureau but not in compliance with Rule 17.1(a) or (b)** (the priority document was received after the time limit prescribed in Rule 17.1(a) or the request to prepare and transmit the priority document was submitted to the receiving Office after the applicable time limit under Rule 17.1(b)). Even though the priority document was not furnished in compliance with Rule 17.1(a) or (b), the International Bureau will nevertheless transmit a copy of the document to the designated Offices, for their consideration. In case such a copy is not accepted by the designated Office as priority document, Rule 17.1(c) provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

| <u>Priority date</u> | <u>Priority application No.</u> | <u>Country or regional Office or PCT receiving Office</u> | <u>Date of receipt of priority document</u> |
|---------------------------|---------------------------------|---|---|
| 31 Octo 2002 (31.10.2002) | MI2002A02329 | IT | 16 Janu 2004 (16.01.2004) |

| | |
|--|--|
| <p>The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland</p> <p>Facsimile No. (41-22) 338-7060</p> | <p>Authorized officer Maya BAICHI</p> <p>Telephone No. (41-22) 338 9802</p> |
|--|--|

PATENT COOPERATION TREATY

PCT/IB2003/005111

From the INTERNATIONAL BUREAU

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|-------------|-----|
| PC | PC |
| PC | PC |
| 25 MAY 2004 | |
| PC | PCT |

NOTICE INFORMING THE APPLICANT OF THE
COMMUNICATION OF THE INTERNATIONAL
APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

To:

CARDUS, Alan, Peter
Marconi Intellectual Property
Crompton Close
Basildon
Essex SS14 3BA
ROYAUME-UNI

| | | |
|--|--|--|
| Date of mailing (day/month/year) 13 May 2004 (13.05.2004) | | |
| Applicant's or agent's file reference P/63773/GPTX18 | | IMPORTANT NOTICE |
| International application No. PCT/IB2003/005115 | International filing date (day/month/year) 13 October 2003 (13.10.2003) | Priority date (day/month/year) 31 October 2002 (31.10.2002) |
| Applicant MARCONI COMMUNICATIONS SPA et al | | |

1. Notice is hereby given that the International Bureau has **communicated**, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this notice:

AU, AZ, BY, CH, CN, CO, DZ, EP, HU, JP, KG, KP, KR, MD, MK, MZ, RU, TM, US

In accordance with Rule 47.1(c), third sentence, those Offices will accept the present notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time:

AE, AG, AL, AM, AP, AT, BA, BB, BG, BR, BZ, CA, CR, CU, CZ, DE, DK, DM, EA, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, ID, IL, IN, IS, KE, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MG, MN, MW, MX, NI, NO, NZ, OA, OM, PG, PH, PL, PT, RO, SC, SD, SE, SG, SK, SL, SY, TJ, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW

The communication will be made to those Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this notice is a copy of the international application as published by the International Bureau on 13 May 2004 (13.05.2004) under No. WO 2004/040809

4. **TIME LIMITS for filing a demand for international preliminary examination and for entry into the national phase**

The applicable time limit for entering the national phase will, **subject to what is said in the following paragraph**, be **30 MONTHS** from the priority date, not only in respect of any elected Office if a demand for international preliminary examination is filed before the expiration of **19 months** from the priority date, but also in respect of any designated Office, in the absence of filing of such demand, where Article 22(1) as modified with effect from 1 April 2002 applies in respect of that designated Office. For further details, see *PCT Gazette* No. 44/2001 of 1 November 2001, pages 19926, 19932 and 19934, as well as the *PCT Newsletter*, October and November 2001 and February 2002 issues.

In practice, **time limits other than the 30-month time limit** will continue to apply, for various periods of time, in respect of certain designated or elected Offices. For **regular updates on the applicable time limits** (20, 21, 30 or 31 months, or other time limit), Office by Office, refer to the *PCT Gazette*, the *PCT Newsletter* and the *PCT Applicant's Guide*, Volume II, National Chapters, all available from WIPO's Internet site, at <http://www.wipo.int/pct/en/index.html>.

For filing a **demand for international preliminary examination**, see the *PCT Applicant's Guide*, Volume I/A, Chapter IX. Only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination (at present, all PCT Contracting States are bound by Chapter II).

It is the applicant's **sole responsibility** to monitor all these time limits.

| | |
|---|---|
| The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland | Authorized officer Gabriele Bähr |
| Facsimile No. +41 22 740 14 35 | Facsimile No. +41 22 338 70 60 |

PATENT COOPERATION TREATY

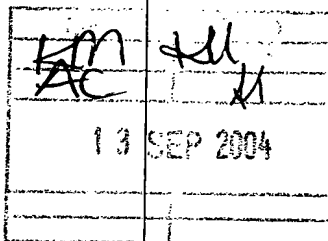
From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

PCT

WRITTEN OPINION
(PCT Rule 66)

To:

CARDUS, Alan, Peter
Marconi Intellectual Property
Crompton Close
Basildon
Essex SS14 3BA
GRANDE BRETAGNE



Date of mailing
(day/month/year)

13.09.2004

Applicant's or agent's file reference
P/63773/GPTX18

REPLY DUE

within 3 month(s)
from the above date of mailing

International application No.
PCT/IB 03/05115

International filing date (day/month/year)
13.10.2003

Priority date (day/month/year)
31.10.2002

International Patent Classification (IPC) or both national classification and IPC
H04B10/17

Applicant

MARCONI COMMUNICATIONS SPA

1. This written opinion is the **first** drawn up by this International Preliminary Examining Authority.
2. This opinion contains indications relating to the following items:
 - I ☒ Basis of the opinion
 - II ☐ Priority
 - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
 - IV ☐ Lack of unity of invention
 - V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
 - VI ☐ Certain documents cited
 - VII ☐ Certain defects in the international application
 - VIII ☐ Certain observations on the international application
3. The applicant is hereby **invited to reply** to this opinion.

When? See the time limit indicated above. The applicant may, before the expiration of that time limit, request this Authority to grant an extension, see Rule 66.2(d).

How? By submitting a written reply, accompanied, where appropriate, by amendments, according to Rule 66.3. For the form and the language of the amendments, see Rules 66.8 and 66.9.

Also: For an additional opportunity to submit amendments, see Rule 66.4.
For the examiner's obligation to consider amendments and/or arguments, see Rule 66.4 bis.
For an informal communication with the examiner, see Rule 66.6.

If no reply is filed, the international preliminary examination report will be established on the basis of this opinion.
4. The final date by which the international preliminary examination report must be established according to Rule 69.2 is: 28.02.2005

Name and mailing address of the international preliminary examining authority:



European Patent Office - P.B. 5818 Patentlaan 2
NL-2280 HV Rijswijk - Pays Bas
Tel. +31 70 340 - 2040 Tx: 31 651 epo nl
Fax: +31 70 340 - 3016

Authorized Officer

Reville, L

Formalities officer (incl. extension of time limits)

Van Deursen, T

Telephone No. +31 70 340-3478



I. Basis of the opinion

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this opinion as "originally filed"*):

Description, Pages

1-14 as originally filed

Claims, Numbers

1-20 as originally filed

Drawings, Sheets

1/3-3/3 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
☐ the language of publication of the international application (under Rule 48.3(b)).
☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
☐ filed together with the international application in computer readable form.
☐ furnished subsequently to this Authority in written form.
☐ furnished subsequently to this Authority in computer readable form.
☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

5. ☐ This opinion has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

6. Additional observations, if necessary:

V. Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**1. Statement**

| | | |
|-------------------------------|--------|------|
| Novelty (N) | Claims | |
| Inventive step (IS) | Claims | 1-20 |
| Industrial applicability (IA) | Claims | |

2. Citations and explanations**see separate sheet**

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Reference is made to the following documents:
D1: US-A-6 160 657 (LEE SEUNG-HEE ET AL) 12 December 2000 (2000-12-12)
D2: US-B-6 441 950~~X~~(CHEN CHIEN-JEN ET AL) 27 August 2002 (2002-08-27)
2. The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claim 1 does not involve an inventive step in the sense of Article 33(3) PCT.

The document D1 is regarded as being the closest prior art to the subject-matter of claim 1 and discloses (the references in parentheses applying to this document):
a means for controlling the gain of an optical amplifier (column 2, lines 21-29) comprising a source for generating a gain control signal (column 2, lines 35-37), an optical amplifier for receiving one or more optical input signal channels at a first end (column 2, lines 33-35) and means for providing the gain control signal to the optical amplifier at the other end; in which the source is arranged to generate the gain control signal at a power level that produces stimulated Brillouin scattering (SBS) in the optical amplifier (column 2, lines 38-44).

waltz!
The subject-matter of claim 1 therefore differs from this known prior art, D1, in that: the source is placed in a different position. However, merely changing the location of a source would be considered by a person skilled in the art as a normal design option.

Thus, the solution proposed in claim 1 of the present application cannot be considered as involving an inventive step (Article 33(3) PCT).

The same reasoning applies, mutatis mutandis, to the subject-matter of the corresponding independent claim 12 which therefore is also considered not inventive.

3. Dependent claims 9, 10, 11 and 20 do not contain any features which meet the requirements of the PCT in respect of inventive step. The subject-matter of these dependent claims can be found in document D1.

4. The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claims 2-4, 6-8, 13-15 and 17-19 is not inventive in the sense of Article 33(3) PCT.

The subject-matter of claims 2-4, 6-8, 13-15 and 17-19 therefore differs from this known in D1 in that:

- it comprises control means for identifying a change in the input signal and for varying the gain control signal power level to compensate for the identified change.
- in which the control means comprises monitor means for monitoring the power of the input signal and for varying the gain control signal power level to compensate for changes in the monitored power.
- in which the control means comprises means for obtaining information on the input signal channel or channels from an optical supervisory channel or pilot tone.
- further comprising means for monitoring the power level of the gain control signal.
- in which the amplifier is a distributed Raman amplifier .

The problem to be solved by the present invention may therefore be regarded as how to improve control of a Raman amplifier.

However the solution proposed in claims 2-4, 6-8, 13-15 and 17-19 already exists in D2 and is disclosed in (the references in parentheses applying to document D2)

- it comprises control means for identifying a change in the input signal and for varying the gain control signal power level to compensate for the identified change (column 2, lines 1-4).
- in which the control means comprises monitor means for monitoring the power of the input signal and for varying the gain control signal power level to compensate for changes in the monitored power (column 10, lines 5-10).
- in which the control means comprises means for obtaining information on the input signal channel or channels from an optical supervisory channel or pilot tone (column 10, lines 5-7).
- further comprising means for monitoring the power level of the gain control signal (column 10, lines 12-23).
- in which the amplifier is a distributed Raman amplifier (column 10, lines 65-67) .

Thus the present application cannot be considered as involving an inventive step (Article 33(3) PCT)

5. The subject-matter of dependent claims 5 and 16 is implicit in the prior art documents.

Additional Remarks

6.1 To meet the requirements of **Rule 5.1(a)(ii) PCT**, the documents D1 and D2 should be identified in the description and the relevant background art disclosed therein should be briefly discussed. ✓

6.2 When filing amended claims the applicant should at the same time bring the description into conformity with the amended claims. Care should be taken during revision, especially of the introductory portion including any statements of problem or advantage, not to add subject-matter which extends beyond the content of the application as originally filed (**Article 34(2)(b) PCT**). ✓

6.3 In order to facilitate the examination of the conformity of the amended application with the requirements of **Article 34(2)(b) PCT**, the applicant is requested to clearly identify the amendments carried out, irrespective of whether they concern amendments by addition, replacement or deletion, and to indicate the passages of the application as filed on which these amendments are based (**see also Rule 66.8(a) PCT**). ✓

If the applicant regards it as appropriate these indications could be submitted in handwritten form on a copy of the relevant parts of the application as filed.

6.4 Independent claims 1 and 12 are not in the two-part form in accordance with **Rule 6.3(b) PCT**, which in the present case would be appropriate, with those features known in combination from the prior art documents being placed in the preamble (**Rule 6.3(b)(i) PCT**) and with the remaining features being included in the characterising part (**Rule 6.3(b)(ii) PCT**). Independent claims 1 and 12 should therefore be redrafted accordingly. ✓

6.5 The features of the claims should be provided with reference signs placed in parentheses to increase the intelligibility of the claims (**Rule 6.2(b) PCT**). ✓

6.6 The attention of the applicant is drawn to the following clerical errors:

- Claim 1, line 1 - "a" optical amplifier should be replaced by "an" optical amplifier
- Description, page 5, line 8 - "A" means should be replaced by "a" means
- Description, page 5, line 13 - the sentence is not complete. ✓

**WRITTEN OPINION
SEPARATE SHEET**

International application No. PCT/IB 03/05115



Processing Team 1
The International Bureau of WIPO
34, chemin des Colombettes
121 Geneva 20
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Web site: www.marconi.com

18 March, 2005

Your Ref: PCT/ B2003/005115

Our Ref: P/63773.WOP

Dear Sirs,

International Patent Application No. PCT/IB2003/005115-- Recording of the change of applicant to include joint applicant Marconi Communications Ltd

The above reference International patent application currently has the applicant as Marconi Communications SpA in respect of all designated states except the USA. Pursuant to Rule 92*bis*.1(a) PCT, I hereby request that a further joint applicant be recorded in respect of all designated states except the USA. The full particulars for the joint applicant are:

Marconi Communications Ltd
New Century Park
P O Box 53
Coventry
CV3 1HL
United Kingdom (GB)

State of nationality: GB
State of residence: GB

Telephone No. +44 (0) 2476 562000
Facsimile No. +44 (0) 2476 562247

Yours faithfully



Ian COLLIER



European Patent Office
PB 5818 Patentlaan 2
2280 HV Rijswijk (ZH)
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BY FACSIMILE – CONFIRMATION BY POST

30 November, 2004

Your Ref:

Our Ref: P/63773.WOP/X18/APC/

Dear Sirs,

**Re: International Patent Application No. IB 03/05115
Marconi Communications SpA
Written Opinion dated 13.09.2004**

According to the above communication, independent claims 1 and 12, together with dependent claims 9-11 and 20 are considered to lack an inventive step (Art. 33(3) PCT) on the basis of D1 (US-A-6 160 657). The remaining dependent claims are considered to lack an inventive step on the basis of D1 in combination with D2 (US-B-6 441 950). However, the teaching of D1 and D2 is not correctly interpreted in the Communication.

D1 discusses an optical amplifier in which gain is maintained during changes in the number of input optical channels by use of stimulated Brillouin scattering. However, D1 does not describe the arrangement of the present invention according to which, the gain control is effected by generation of Brillouin scattering in a Raman amplifier by means of a control signal input at the opposite end of the amplifier to the signal.

D1 relies on having a third order non-linear material that is not required by the present invention. The third order material used in D1 is provided in an extra stage separate from the gain medium. This extra stage is used to generate Brillouin scattered light directed back to the gain medium (as mentioned in the abstract and in column 2 line 44,45,46). The present invention avoids this extra stage and does not need third order material. According to claim 1, Brillouin scattering is achieved in the normal optical material (gain medium) making up the amplifier, i.e. the Brillouin scattering used by the present invention takes place in the amplifier stage itself. Advantageously, the present invention does away with the need for the extra, non-linear stage described in D1.

Furthermore, according to D1, the Brillouin scattering is triggered by the signal emerging at the output of the amplification stage. In contrast, the present invention achieves Brillouin scattering by providing a gain-control signal entering the amplifier at its output: i.e. directed in the opposite direction to that of D1. This brings a considerable advantage when compared to conventional systems, as explained below.

The gain-control signal of the present invention suffers attenuation as it travels through the Raman amplifier towards the input. This is a significant effect in Raman amplifiers that are distributed along great lengths of fibre, unlike other types of optical amplifier that are much more compact. As the gain-control signal travels in the opposite direction to the input signal, the attenuation it suffers as it travels through the Raman amplifier results in a reduction in Brillouin scattering towards the input of the amplifier. The Raman pump signal also enters the amplifier at the output and is also attenuated as it moves through the amplifier fibre towards the input. As a result, the degree of amplification decreases towards the input. Taken together, this means that the gain-reducing effect of the Brillouin scattering is lower in those parts of the fibre that have lower gain. Advantageously, the present invention modifies the behaviour of the Raman amplifier to equalise gain throughout the extended Raman amplifier.

This is not found in any of the cited prior art, nor is there any teaching that would lead the skilled reader to modify the arrangements set out in the prior art to arrive at the present invention. In particular, merely changing the direction of the signal that generates the Brillouin scattering in the third-order nonlinear material of D1 would in fact cause the Brillouin scattered light to travel in the opposite direction, i.e. away from, rather than into, the amplifier.

D1 does not mention Raman amplifiers and the arrangement described there would not appear to be compatible with Raman amplifier design. In particular, Raman amplifiers are distributed over very long fibres and do not require non-linear material. This may explain why the authors of D1 describe a gain-control arrangement that is fundamentally different from the present invention.

For the above reasons, claim 1 is both novel and inventive when compared with the cited prior art. Claim 12 is a method claim with features corresponding to those of claim 1 and is similarly novel and inventive.

For completeness, we shall also consider the teaching of D2; cited as disclosing optical amplifier control means not found in D1. Unlike D1, the optical amplifier system of D2 uses a Raman amplifier. The skilled reader would see the teaching of D2 to be incompatible with the arrangement of D1. In order to import the teaching of D2 into D1 would require the optical amplifier of D1 to be replaced by a Raman amplifier. Simply doing this would result in a system that would not work. In order to arrive at a working design would require a number of further significant changes to the arrangement of D1. In particular, D2 teaches gain-control without the use of Brillouin scattering. The combination of D1 and D2 would result in discarding the extra, Brillouin-generating, non-linear stage of D1. The combination of D1 and D2 proposed by the Examiner would not be an obvious choice to the skilled worker, would require considerable redesign effort and, if pursued, would not result in the combination of features found in claim 1.

Both D1 and D2 are identified and briefly discussed in the introduction to the description at page 1.

Main claims 1 and 12 are rendered in the two-part form in the light of D1 or D2. The gain control signal is not found in D1. In D2, the telemetry described is so different in nature to the gain control signal of the present invention that it is not considered appropriate to place the gain control signal in the precharacterising part.

No reference signs suitable for inclusion in the claims are present in the drawings.

The following errors in the specification, kindly indicated by the Examiner, are corrected. Claim 1, line 1, replace "a" with "an"; description, page 5, line 8, replace "A" with "a" (both obvious typographical errors); line 13 insert "amplifier" (based on claim 1 as originally filed).

For clarity, in Claims 1 and 12, last line, delete "(SBS)": this abbreviation is not required in the claims.

Page 4 of the Written Opinion is blank. For the purposes of this response, it is assumed that no text has been omitted from the Written Opinion.

The following pages are filed herewith and replace corresponding pages currently on file: 1, 1a, 5 and 15-17. In addition, copies of these pages are attached for the convenience of the Examiner with changes marked.

Yours faithfully

A handwritten signature in black ink, appearing to be 'A.P. Cardus', with a stylized flourish at the end.

A.P. Cardus

OPTICAL SYSTEM

The present invention relates to the field of optical systems in general and, in particular, to means for controlling the gain of optical amplifiers.

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Several types of optical amplifier have been proposed to overcome the effect of signal attenuation in optical transmission paths, particularly fibre. These amplifier types include erbium doped fibre amplifier (EDFA), Thulium doped Silica fibre amplifier (TDSFA), Thulium doped Telluride amplifier (TDTFA), lumped Raman amplifier (RA) and distributed RA.

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US-A-6 160 657 to Lee Seung-Hee et. al., describes a non-Raman optical amplifier in which the levels of signals output from the amplifier is limited during changes in the number of input optical channels by use of stimulated Brillouin scattering generated in a separate, non-linear stage and fed to the output of the gain stage.

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US-BI-6 441 950 to Chen Chien-Jen et. al., describes a distributed Raman amplifiers and a conventional arrangement for measurement of optical signal power levels and for controlling amplifier gain to compensate for changes in power levels not using Brillouin scattering.

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Raman gain in an optical network is an extremely important means for compensating for signal attenuation or loss in transmission fibre by exploiting stimulated Raman scattering

power of both (gain control and signal) channels tends to exponentially decrease along the transmission medium. This means that the total aggregate optical power in the amplifier fibre will vary along the length of the fibre and will not keep to the desired constant level

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- 2) A counter-propagating gain control signal would also not achieve the desired effect because the amplifier gain in a certain direction is determined by the aggregate power level of the signals propagating through the optical amplifier in that direction. The power level of a signal propagating through an amplifier in a first direction will not affect the amplifier gain in the opposite direction.

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The object of the present invention is to overcome the above shortcomings and to provide an improved means of controlling gain in an optical amplifier. This object is achieved by use of a gain control signal. Ideally, the control signal should be at a high level where the signal channels are at a low level and vice versa in order to achieve a constant total power in the fibre along the whole length.

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The present invention provides A-a means for controlling the gain of a optical amplifier comprising a source for generating a gain control signal, an optical amplifier for receiving one or more optical input signal channels at a first end and means for providing the gain control signal to the optical amplifier at the other end; in which the source is

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arranged to generate the gain control signal at a power level that produces stimulated Brillouin scattering (SBS) in the optical amplifier.

- 5 The present invention also provides a method of controlling the gain of an optical amplifier comprising the steps of introducing one or more optical input signal channels into a first end of the optical amplifier, generating a gain control signal and introducing the gain control signal at the other end of the optical amplifier, in which the gain control signal is generated at a power level that produces stimulated Brillouin scattering (SBS) in
10 the optical amplifier.

Embodiments of the invention will now be described by way of example with reference to the figures in which:

- 15 Figures 1 and 2 show conventional amplifier arrangements;

Figure 3 shows an amplifier arrangement according to the present invention;

Figures 4 and 5 show signal propagation in a fibre; and

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Figure 6 shows the gain spectrum for a typical distributed Raman amplifier.

CLAIMS

1. A means for controlling the gain of an optical amplifier characterised in that it comprises a source for generating a gain control signal, an optical amplifier for receiving one or more optical input signal channels at a first end and means for providing the gain control signal to the optical amplifier at the other end; in which the source is arranged to generate the gain control signal at a power level that produces stimulated Brillouin scattering (SBS) in the optical amplifier.
2. The means according to claim 1 comprising control means for identifying a change in the input signal and for varying the gain control signal power level to compensate for the identified change.
3. The means according to claim 2 in which the control means comprises monitor means for monitoring the power of the input signal and for varying the gain control signal power level to compensate for changes in the monitored power.
4. The means according to claim 2 or 3 in which the control means comprises means for obtaining information on the input signal channel or channels from an optical supervisory channel or pilot tone.
5. The means according to any above claim in which the gain control signal falls within the gain bandwidth of the optical amplifier.

6. The means according to any above claim further comprising means for monitoring the power level of the gain control signal.
7. The means according to any above claim in which the amplifier is a Raman amplifier.
8. The means according to claim 7 in which the amplifier is a distributed Raman amplifier
9. The means according to any one of claims 1 to 6 in which the amplifier is a rare earth doped fibre amplifier.
10. An optical amplifier comprising the means according to any one of claims 1 to 9.
11. An optical communications system comprising the means according to any one of claims 1 to 9 or the amplifier according to claim 10.
12. A method of controlling the gain of an optical amplifier characterised in that it comprising the steps of introducing one or more optical input signal channels into a first end of the optical amplifier, generating a gain control signal and introducing the gain control signal at the other end of the optical amplifier, in

which the gain control signal is generated at a power level that produces stimulated Brillouin scattering (SBS) in the optical amplifier.

13. . The method according to claim 12 including the steps of identifying a change in the input signal and varying the gain control signal power level to compensate for the identified change.
14. The method according to claim 13 including the step of monitoring the power of the input signal and varying the gain control signal power to compensate for a change in the monitored power.
15. The method according to claim 13 or 14 including obtaining information on the signal channels from an optical supervisory channel or pilot tone.
16. The method according to any of claims 12 to 15 in which the gain control signal falls within the gain bandwidth of the optical amplifier.
17. The method according to any of claims 12 to 16 further including the step of monitoring the power level of the gain control signal.
18. The method according to any of claims 12 to 17 in which the amplifier is a Raman amplifier.